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UNITED STATES DEPARTMENT OF COMMERCE  
National Telecommunications and  
Information Administration  
Washington, D.C. 20230

September 13, 1996

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Michele Farquhar  
Chief, Wireless Bureau  
Federal Communications Commission  
1919 M Street, NW  
Washington, D.C. 20554

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Dear Ms. Farquhar:

FEDERAL COMMUNICATIONS COMMISSION  
OFFICE OF SECRETARY

The Commission, in its First Report and Order (FCC 96-311), adopted a band plan designating discrete spectrum segments for the Local Multipoint Distribution Service (LMDS) and other services in the 27.5 - 30.0 GHz band. Also in this order, the Commission directed its staff to continue discussions with the National Telecommunications and Information Administration (NTIA) to explore the feasibility of shared use or reallocation of some portion of the 25.25 - 27.5 GHz band for LMDS (§39). We also note that this band is the only government exclusive fixed and mobile band above 20 GHz.

As you may know, NASA, at our direction, has planned for many years to use the 25.25 - 27.5 GHz band for its Tracking and Data Relay Satellite System, and has recently let a \$500 million contract to build the TDRS H, I and J satellites. Other initiatives include a Payload Operations Communications System for International Space Station Alpha and direct-to-Earth downlinks for the Earth Exploration-Satellite Service. These activities are global in scope, involving major foreign administrations, and are being carried out pursuant to National Space and Foreign Affairs Policies. Because of these extensive, complex endeavors, NTIA, as well as NASA, are quite concerned about the use of the band by any incompatible service.

Extensive work has been performed on the issue of sharing in this band. We have compiled, from various source documents, a summary of the history, planned usage and potential sharing situations for the band 25.25 - 27.5 GHz, a copy of which is enclosed with this letter, along with a number of documents providing additional information on this topic. I hope that this summary will clarify the key issues involved in the use of this band by government agencies and the inability to share with LMDS.

Finally, as discussed in my letter of May 14, 1996 to the FCC, NTIA has modified the Government portion of the National Table of Frequency Allocations for this exclusive Government band to include the Inter-Satellite Service and we encourage the Commission to reflect this change in the Commission version of this Table.

Sincerely,

Richard Parlow  
Associate Administrator,  
Office of Spectrum Management

cc: Don Gips, Chief, International Bureau  
Richard Smith, Chief, Office of Engineering and Technology

ENCLOSURE

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List A B C D E

## **History and usage of the band 25.25 - 27.5 GHz by NASA and other Space Agencies**

The 25.25 - 27.5 GHz band will be used by NASA and the other space agencies around the world for a variety of activities which cannot be accommodated in other frequency bands. The history of the allocation, which stretches back to 1985, includes the primary allocation to the Inter-Satellite service made at WARC-92 and proposals to consider a primary allocation to Earth Exploration-Satellite Service at WARC-97. Current and planned usage of the band include a wide range of missions by the United States, Japan, Russia and the European Space Agency. Sharing between the space services and fixed point-to-multipoint systems has been analyzed in 4 studies and found to be infeasible.

The following sections of this paper address the history and usage of the band 25.25 - 27.5 GHz as well as sharing analyses between the space science services and fixed point-to-multipoint services. All the documents referenced in this paper are listed by topic at the end of the paper. Attached to this paper are copies of the more significant documents.

### **Allocation Status History**

The frequency band 25.25 - 27.5 GHz is allocated, in the Radio Regulations, to the fixed service, the mobile service, and the inter-satellite service on a primary basis as shown in Figure 1. The frequency band 27.0 - 27.5 GHz is also allocated, on a primary basis, to the fixed-satellite service in the Earth-to-space direction. Additionally, secondary allocations to the standard frequency and time signal-satellite service, in the Earth-to-space direction, and to the Earth exploration-satellite service (25.5 - 27.0 GHz), in the space-to-Earth direction, exist.

Further, the allocation to the inter-satellite service is constrained by RR 881A, which reads "Use of the 25.25-27.5 GHz band by the inter-satellite service is limited to space research and Earth-exploration-satellite applications, and also transmissions of data originating from industrial and medical activities in space", and in Regions 2 & 3, RR 881B applies, reading "Space services using non-geostationary satellites operating in the band 27-27.5 GHz are exempt from the provisions of No. 2613".

It should be noted that, in response to the worldwide need for more space-to-Earth bandwidth for environmental and Earth resources data (the band 8025 - 8400 MHz is already congested), the issue of the allocation to the Earth exploration-satellite service in the band 25.5 - 27.0 GHz has been placed on the agenda of WRC-97. Draft US proposals have been prepared within the FCC Advisory Committee and the IRAC RCS seeking to upgrade the EESS allocation from secondary to Primary in this band.

### ***Genesis of space science allocation***

The genesis of the allocations to the inter-satellite service and the Earth-exploration-satellite service is summarized below:

- GWARC-79 Allocation made to Earth Exploration Satellite Service (space-to-space) in response to space science service needs. Primary status was proposed but WARC made secondary allocation to allay fears from terrestrial services.
- 1981 CCIR publishes system characteristics of advanced data relay satellite system.
- 1985 ESA, NASA and NASDA establish the Space Network Interoperability Panel (SNIP). SNIP given the task, with advice from Space Frequency Coordination Group (SFCG), to identify the 'right' frequency band for future Data Relay Satellite (DRS) and proximity link operations.

- 1985 In responding to discussions on spectrum support for the Space Station, NTIA informs NASA that implementation of long-term, wide-band space-to-space systems below 20 GHz causes significant regulatory problems.
- 1986 SFCG recommends, based on technical studies, that 25.25 - 27.5 GHz is the preferred band for the return links. ESA, NASA & NASDA agree formally that future communications systems for DRS and Space Station support should be implemented in the 22.55 - 23.55 GHz band (forward link) and 25.25 - 27.5 GHz band (return link). SNIP starts work on the channel plan for these two bands.
- 1987 NTIA denies NASA request to use 14.0 - 14.5 GHz for Space Station and urges NASA to consider bands above 20 GHz, "In particular, the bands 22.55 - 23.55 GHz and 25.25 - 27.0 GHz should be considered."
- 1987 SFCG-7, Paris, 1987, space agencies agree that 1) a change must be made to the table of frequency allocations, to provide a primary allocation from 25.25 - 27.5 GHz to enable communication links in future space communication systems and, 2) that the bands 25.25 - 25.6 GHz and 27.1 - 27.5 GHz should be designated for proximity operations to support communications between spacecraft on orbit within about 40 km of each other.
- 1989 Plenipotentiary Conference sets WARC date, includes space issues in agenda.
- 1992 WARC 1992, in response to a number of proposals, provides a primary allocation to the inter-satellite service in the 25.25 - 27.5 GHz band.  
WARC-92 also advises space science services to take all possible space communication systems above 20 GHz, particularly those having higher bandwidth and/or data rate requirements (Resolution 711).
- 1993 SNIP finalizes channel plans for the band, CCSDS and SFCG concur.
- 1994 NASA (GSFC) obtains approval from the Spectrum Planning Subcommittee to use this band for TDRSS operations (Stage 2).
- 1995 NASA (JSC) obtains approval from the Spectrum Planning Subcommittee for use of this band for proximity operations for the International Space Station program (Stage 1). SFCG-15 approves Recommendation 15-2 concerning use of this band.

### **1992 Conference actions**

During the deliberations of WARC-1992, it was decided to impose on the fixed service, in the 25.25 - 27.5 GHz band, constraints pertaining to the amount of effective isotropic radiated power which could be emitted by each fixed service station, in order to protect space stations on orbit. The full complement of proper experts was not available at the conference, so a provisional value was assigned pending further work and review by the then CCIR. A provisional power flux density constraint was already in place in the then Article 28 of the Radio Regulations, to protect fixed and mobile systems from interference from space science service systems.<sup>1</sup>

WARC-1992 also resolved "that it is desirable to review the present and planned use of the frequency bands 2025-2110 MHz and 2200-2290 MHz, with the intent, when practicable, of assigning frequencies to some space missions in bands above 20 GHz...". Resolution 711 (WARC-92).

### **Current and Planned Missions in Ka-band**

The 25.25 - 27.5 GHz band will be used by NASA and the other space agencies around the world for a variety of activities which cannot be accommodated in other frequency bands. The currently planned use of the band is presented in the attached figure. As can be seen, the

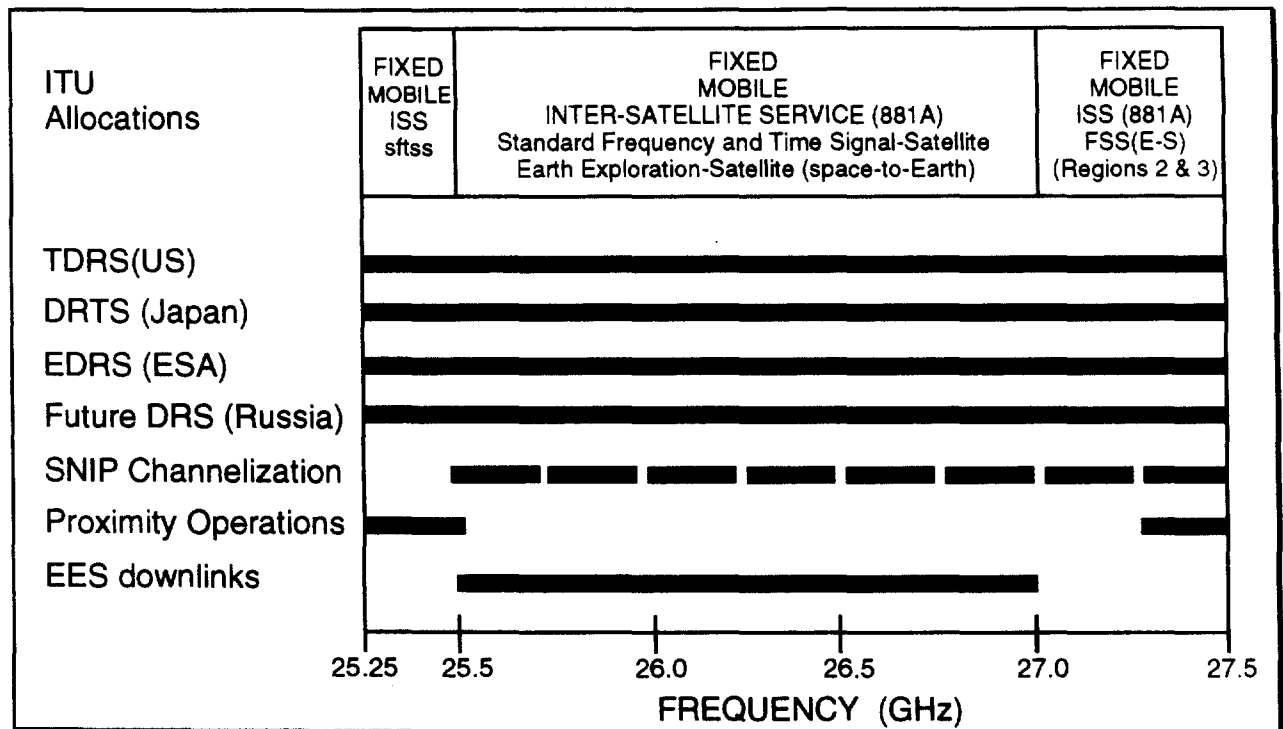
<sup>1</sup> In this paper, the term "space science services" includes, any or all of the following radio services; space research service, Earth exploration-satellite service, space operation service, and inter-satellite service when used for space science applications.

entire band is used by the various data relay satellites (DRS) planned for the band, with different band segments planned for Proximity Operations and Earth exploration-satellite downlinks. These services are discussed below.

- NASA's **TDRS** system has been used to relay data between user satellites and Earth using S-band and Ku-band frequencies since 1983. The TDRS H, I & J satellites, which are currently under contract and planned for launch starting in 1999, will provide these services in the 25.25 - 27.5 GHz band, as well as in the lower frequency bands, thereby increasing capacity and improving service. The TDRS channels are designed to support a maximum data rate of 800 Mbps in a 650 MHz bandwidth in order to accommodate wide-band sensor data. The need to support several of these channels within a given orbital area is foreseen, as well as the need to coordinate channel usage with other administration's relay systems.
  - NASA has requested Stage 4 review for the TDRS H, I and J satellites which will operate across the entire 25.25 - 27.5 GHz band. (Letter to the SPS dated September 13, 1995).
  - NASA has a \$500 Million fixed price contract with Hughes Space and Communications to construct the TDRS H, I and J satellites. Any change to that contract would result in increased costs, for which funding is not available. An additional \$300 million contract has been let with Lockheed Martin to provide an Atlas II launch for the satellites.
  - Development has begun on Ka-band transmitter and receiver hardware for low-Earth orbit DRS user satellites, such as EOS. This will also support direct **EES Downlinks**, described below.
- The **DRTS** system from the National Space Development Agency of Japan (NASDA) will provide the same types of services as will the TDRS. Japan has Advanced Published 5 orbital locations for its DRTS system. In addition, the ETS-VI/Kiku-6 satellite is currently in orbit and operating in this band.
- The **EDRS** system from the European Space Agency (ESA) will also provide data relay type services. Four EDRS satellites have been advanced published by ESA, with an early operational capability to be provided by the Artemis satellite.
- The **Satellite Networks Interoperability Panel (SNIP)**, made up of representatives of NASA, ESA and NASDA, is developing an agreement to allow inter-operable cross-support of each other's spacecraft. The channelization scheme, which is essential for cross-support, covers most of the 25.25 - 27.5 GHz band and is given in the figure.
  - 17 Data Relay satellites have been advanced Published by NASA, ESA and NASDA.
  - The recommended use of the band for DRS activities and a channelization scheme are given in Space Frequency Coordination Group (SFCG) Recommendation 13-3.

- NASA, ESA and NASDA are currently finalizing an agreement which will provide for interoperability of their systems, with the express intent for cross support to their respective missions.
- **Russia**, which currently uses S-band and Ku-band for DRS activities, has long term plans to use the Ka-band as well. This would permit them to transfer their wideband communications links from the interference-prone Ku-band to Ka-band. **India**, which has a very strong space research/Earth exploration-satellite program, may in the future use the Ka-band for DRS communications links.
- NASA is developing a **Proximity Operations Communication System (POCS)** to relay data, television and voice between orbiting vehicles operating in close proximity. This system would be used to support activities ranging from simple telemetry to telerobotics color video. It also may have applications to low-orbit inter-vehicle communications, particularly during docking maneuvers. The figure shows two different bands for POCS, one for transmit and one for receive. These bands must be separated in order to avoid intra-system interference.
  - Stage 1 Certification of Spectrum Support for a POCS system on the International Space Station was received April 5, 1995 .
  - All partners in International Space Station Alpha have indicated the need for such a system.
  - This is the only band available to Space Research for these types of wideband services.
- **EES downlinks** are essential to the development of the US government and commercial Earth sensing activities. The 8,025 - 8,400 MHz band, which is used to downlink EES data direct to Earth, is becoming congested by users of all the allocated space services in that band. The 25.5 - 27.0 GHz band would provide greater bandwidth and better sharing conditions for EES downlinks.
  - A further advantage of using this band is the possibility of using either DRS links or direct downlinks in the same band.
  - Consideration of an allocation to EES in this band is on the WRC-97 agenda.
- **Intensive use** of the Ka-band by US and foreign DRS systems will require careful coordination between the systems to maintain interference free links and Interoperability, such as that which currently facilitates extensive use of S-band. This requires multiple wideband channels for flexibility of operations.
  - The current administration has encouraged interoperability and international cooperation in supporting civil space missions (OMB correspondence dated April 25, 1995). This is one of the drivers which has resulted in international agreements among all DRS operators to access and use the full 25.25 - 27.5 GHz band.

- Another reason for full band use stems from our experience that operational efficiencies are maximized for any given band when users have the flexibility to operate anywhere within the bands. This is even more important as the number of users in the band increases.
- In studying options for the commercialization of TDRS, it is obvious that industry would require maximum flexibility to operate the system in the increasingly complex international environment, therefore requiring the entire 2.25 GHz of available spectrum.



Note: RR 881A reads as follows:

Use of the 25.25 - 27.5 GHz band by the inter-satellite service is limited to space research and Earth exploration-satellite applications, and also transmissions of data originating from industrial and medical activities in space.

**Figure 1. NASA and other Space Agencies operate throughout the Band**

## **Sharing status**

It has long been understood that space science service systems are compatible with fixed and mobile service systems, sharing the same frequency allocation, provided that appropriate technical sharing criteria are agreed upon.

Also it is well-known that the space science services cannot accomplish any mission without the use of Radio Frequencies with which to bring data back to Earth. It is not useful to think in terms of accomplishing these missions by using any kind of connected communication systems, e.g., copper wires, optical fibers or other devices tethered to a given point on the Earth's surface. Certainly fixed systems can and do make use of these communication media, but the space science community simply cannot.

### ***New fixed service systems***

Since WARC-1992, certain fixed and mobile service systems have been proposed which present a different kind of sharing situation, one which would cause unacceptable levels of interference to the space science service systems. The characteristics of such systems which make them different from the traditional (shareable) terrestrial systems, are 1) a much greater population density, and 2) the lack of antenna discrimination at the central hub of each element (cell).

Local Multi-point Distribution Service (LMDS), a cell-based service being proposed for broadband video/data distribution, represents one of the new fixed service systems.

One study of the effects of such high population density systems on space science systems, operating, in that case, near 2 GHz, was carried out in ITU-R Task Group 7/1 (chaired by Canada), resulting in Recommendation ITU-R SA 1154. This Recommendation shows that sharing between space science service systems and high population density terrestrial systems is not feasible.

Currently, sharing between fixed service systems and space science service systems is being studied in ITU-R Joint Ad Hoc group 7B/9D. The allocated frequency bands under consideration are 2025-2110 MHz, 2200-2290 MHz and 25.25-27.5 GHz. Results are expected within the next twelve months.

## **Technical Discussion**

At least four technical studies have been conducted on the impact of introducing LMDS into the band 25.25 - 27.5 GHz, particularly on sharing with the space systems that will use the inter-satellite and Earth exploration-satellite service allocations. In the United States, the FCC requested NASA to conduct one of these studies in seeking to alleviate the LMDS/FSS sharing problems at 28 GHz. NASA provided the results of this study to the international space community in response to SFCG Action Item 15/16. Two studies were conducted in Canada concerning their Local Multipoint Communications Service (LMCS), a system quite similar to LMDS.

- The FCC-requested study by NASA was comprehensive, using parameters and inputs from system operators and planners of the LMDS and space science. Sharing feasibility was assessed between LMDS systems and TDRS, ISS proximity operations and EESS downlinks. The results were clear: sharing is not feasible between the proposed LMDS systems and the space science systems. For 3 out of 4 proposed LMDS system types studied, the value of incompatibility between the relevant signal levels is of the order of 15-30 dB.

- An Industry Canada study input to WP9D (WP7B/9D/CAN1) looked at the lowest power LMCS type system interfering with a data relay satellite (DRS) system and concluded that sharing was feasible under most circumstances, although the margins calculated were small. The study did not address the higher powered LMDS systems planned for the United States. When the higher powered U.S. systems are compared to the Canadian system, it is obvious that the higher powered systems would interfere with DRS receivers. The Canadian study essentially supports the conclusions of the above NASA study.
- A Canadian Space Agency (CSA) commissioned study, by Robert Bowen Associates Ltd., examined the effects on International Space Station proximity operation links due to Canadian LMCS systems. The study took into account the fact that LMCS systems proposed for deployment in Canada may offer different (lower power) operating characteristics than those proposed for deployment in the US. However, even using these less deleterious characteristics, Dr. Bowen came to the conclusion that sharing is not feasible. He suggests that, "A way of avoiding this potential problem without putting tight constraints on the future development of LMCS systems would be to avoid the proximity link frequency bands".
- The NASA paper prepared in response to SFCG Action Item 15/16 (attached) included a comparison of Canadian LMCS system parameters using the same techniques as had been used in the earlier study conducted using US LMDS parameters. The results were in close agreement with those of the Canadian Studies, indicating that, while the actual interference levels generated by emissions of the Canadian systems may be marginal, the worst-case scenario could produce incompatibilities of the order of 10 dB for even the low power Canadian LMCS system parameters.

In each of these studies, the interference received by the DRS satellites POCS receivers is due to the aggregate effect of many LMDS (or LMCS) emitters, not to individual emitters. Coordination in such a situation is not feasible because the characteristics of all the emitters in an area must be controlled, not simply individual emitters.

#### **25.25 - 27.5 GHz or ???**

If systems using the frequency band 25.25 - 27.5 GHz cannot share with LMDS, is there an alternative?

- In the United States, the Federal Communication Commission, in document 96-311 entitled "First Report and Order and Fourth Notice of Proposed Rulemaking on the re-allocation of the 28 GHz Frequency Band" states its intent that LMDS systems be accommodated in the 27.5 - 29.5 GHz band with certain LMDS elements to be implemented in the 31.0 - 31.3 GHz band.
- In July 1995, the European Radiocommunication Office, on behalf of CEPT, issued a ruling identifying the broadcasting service allocation from 40.5 - 42.5 GHz to be used for LMDS-like systems (called Multipoint Video Distribution Systems (MVDS)) in that part of the world.
- LMDS proponents have stated that their economic viability depends on implementation near 30 GHz, but it has been estimated that, because the RF-dependent portion of the systems represents only a fraction of the total system, the incremental cost of implementing near 40 GHz could be as a little as 5%. If passed

on *in toto* to the consumer, this increase represents a subscription of rate of \$31.50 per month, rather than the \$30.00 already foreseen in LMDS sales plans.

Spectrum for expansion of LMDS beyond that identified in the First Report and Order should be sought in the 40.5 - 42.5 GHz band where compatibility with similar systems globally would be assured. Initial LMDS deployment within the proposed 28 GHz spectrum would allow ample time for any necessary technology development to occur in advance of LMDS expansion into the 2 GHz of bandwidth available at 40.5 GHz.

## **Summary**

It has been shown that for a variety of regulatory and technical reasons discussed in this document, it is not possible for Local Multi-point Distribution Service Systems to share with currently planned Federal systems in the frequency band 25.25 - 27.5 GHz. In addition, alternative spectrum is available which would allow future expansion of LMDS without harm to the critical space science services.

## **Document List**

**The following documents are either referenced in this paper or serve to augment the discussions. Those identified as "ATTACHED" are provided as attachments.**

### **History of Ka-band**

- Res. 711 (WARC-92), Possible Relocation of Frequency Assignments to Certain Space Missions from the 2 GHz Band to Bands above 20 GHz. **ATTACHED**
- NTIA letter to NASA regarding spectrum support for Space Station, September 3, 1985. **ATTACHED**
- NTIA letter to NASA regarding spectrum support for Space Station Cluster Links , December 18, 1987. **ATTACHED**

### **Usage of Ka-band**

#### **TDRS Ka-Band**

- ATDRSS (which includes Ka-band) Stage 4 authorization (SPS-8199 & IRAC Doc. 26563).
- TDRS H, I, J Stage 4 authorization requested (submitted August 1996)).

#### **International Space Station Alpha (ISSA)**

- Japanese Experiment Module (JEM) (SFCG 14-36)

#### **Japanese Data Relay Satellites**

- DRTS, KIKU-6, ADEOS ITU-R filings (AR11/A/1403-1404 & 1273, AR11/C/806)
- EDRS ITU-R filings (AR11A/630-633)

#### **Satellite Network Interoperability Panel**

- Recommendations for International Space Network Ka-Band Interoperability, Satellite Network Interoperability Panel, June 1995. **ATTACHED**
- Data Relay Satellite Channel Plans for the 23 and 26 GHz Bands (SFCG Rec. 13-3) **ATTACHED**

#### Proximity Operations Communications System

- Stage 1 Certification Letter **ATTACHED**
- SFCG Rec. 15-2 , Use of the Band 25.25 - 27.5 GHz for Inter-Satellite (Data Relay Satellite and ISS Proximity Links) and Earth Exploration satellite service applications **ATTACHED**

#### EES Downlinks

- Necessary Bandwidths and preferred frequency Bands for Data transmission from Earth Exploration-Satellites (Not Including Meteorological Satellites) (WP 7C/TEMP/11) **ATTACHED**
- Additional Requirements for EESS Spectrum(USWP 7C/63 Rev. 3)

#### Intensive Use

- This administration encourages interoperability and cooperation (OMB correspondence 4/25/95)

#### Ka-Band Sharing Situation

- Feasibility of sharing between NASA Space Systems and LMDS near 27 GHz (Submitted to the FCC, April 19, 1996) **ATTACHED**
- Considerations for Bandsharing Between the Inter-Satellite and the Fixed Service Employing Local Multipoint Communications Systems ([Document WP 7B/9D/CAN1]) **ATTACHED**
- On sharing of Portions of the Band 25.25-27.5 GHz between the Proximity Links in the Inter-Satellite Service and Local Multipoint communications Systems in the Fixed Service (SFCG Document SF15-39). **ATTACHED**
- Sharing of EES Space-to-Earth links with other services in the 25.5 - 27.5 GHz Band (USWP 7C/67 Rev. 3). **ATTACHED**
- ITU-R SA.1154, Provisions to protect the Space Research, Space Operations and Earth Exploration-Satellite Services and to Facilitate Sharing with Mobile Services in the Band 2 025 - 2 110 MHz and 2 200 - 2 290 MHz Bands. **ATTACHED**
- 41 GHz Suitability for Whole or Partial Accommodation of LMDS, Comments of the National Aeronautics and Space Administration. **ATTACHED**



Mr. Richard M. Smith  
Chief, Office of Engineering and Technology  
Federal Communications Commission  
Washington, D.C. 220554

Dear Mr. Smith: *Rich*

NTIA, in consultation with the IRAC, has had under consideration for nearly five years the proposal to add the inter-satellite service on a primary basis for the Government to the bands from 25.25 to 27.5 GHz.

The intent of the Federal Government to use these bands for inter-satellite operations has been quite clear. In response to a Government requirement, the U.S. proposals to the 1992 WARC included the reallocation of these bands to the inter-satellite service to provide a primary allocation for wide bandwidth space-to-space data return links from user spacecraft to a data relay satellite and for wideband links between a permanent space station and co-orbiting free flyers. WARC-92 adopted this proposal and further limited (see RR881A) the use of the inter-satellite service to space research and Earth exploration-satellite applications and also to transmissions of data originating from industrial and medical activities in space.

WARC-92 also deleted the secondary allocation to the Earth Exploration Satellite (space-to-space) Service in the 25.25-25.5 and 27.0-27.5 GHz bands and changed the directional indicator on the allocation to the Earth Exploration Satellite Service from (space-to-space) to (space-to-Earth) in the 25.5-27.0 GHz band.

To implement WARC-92, the final report of IRAC Ad Hoc 206 (Doc. 28108 dated November 1992) included the recommendation that this allocation and footnote be adopted in the National Table of Frequency Allocations. The IRAC, with participation of the FCC, endorsed this recommendation. NASA has confirmed that the requirement to use this band for inter-satellite applications, including low-earth orbiting satellites, is still valid. The European, Russians and Japanese are also targeting this band for similar operations.

NTIA is amending the Government portion of the National Table of Frequency Allocations as indicated in the attached table and suggests the FCC may want to amend the non-Government portion to delete the Earth Exploration Satellite Service in the two bands and change the directional indicator in the other band.

Sincerely,

A handwritten signature in dark ink, appearing to read "Rich", followed by a long horizontal stroke.

Richard Farlow  
Associate Administrator

# TABLES OF FREQUENCY ALLOCATIONS

| INTERNATIONAL   |                 |                 | UNITED STATES |   |  |         |
|-----------------|-----------------|-----------------|---------------|---|--|---------|
| Region 1<br>GHz | Region 2<br>GHz | Region 3<br>GHz | Band<br>GHz   | Government<br>Allocation  | Non-Government<br>Allocation   | Remarks |
|                 |                 |                 |               |   |  |         |
|                 |                 |                 |               |   |  |         |
|                 |                 |                 | 25.25-27.25.5 | FIXED<br><u>INTER-SATELLITE 881A</u><br>MOBILE<br><del>Earth Exploration-<br/>Satellite (space-to-<br/>space)</del><br>Standard Frequency<br>and Time Signal-<br>Satellite (Earth-to-<br>space)     | Earth Exploration<br>Satellite (space-to-<br>space)<br>Standard Frequency<br>and Time Signal<br>Satellite (Earth-to-<br>space)       |         |
|                 |                 |                 | 25.5-27       | FIXED<br><u>INTER-SATELLITE 881A</u><br>MOBILE<br>Earth Exploration-<br>Satellite (space-to-<br><del>space</del> Earth)<br>Standard Frequency<br>and Time Signal-<br>Satellite (Earth-to-<br>space) | Earth Exploration-<br>Satellite (space-to-<br>space) ---<br>Standard Frequency<br>and Time Signal-<br>Satellite (Earth-to-<br>space) |         |
|                 |                 |                 | 27-27.5       | FIXED<br><u>INTER-SATELLITE 881A</u><br>MOBILE<br>Earth Exploration<br>Satellite (space-to-<br>space)   | Earth Exploration<br>Satellite (space-to-<br>space)  |         |
|                 |                 |                 |               |   |  |         |
|                 |                 |                 |               |   |  |         |
|                 |                 |                 |               |   |  |         |

RESOLUTION No. 711 (WARC-92)

be this matter on the agenda of the conference.


**Possible Relocation of Frequency Assignments to Certain Space Missions from the 2 GHz Band to Bands above 20 GHz**

The World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum (Malaga-Torremolinos, 1992),

*considering*

- a) the changes in the allocations to space services made by this Conference in the bands 2 025 - 2 110 MHz and 2 200 - 2 290 MHz;
- b) the possibility of technical improvements in the space services concerned which might lead to more efficient usage of the spectrum;
- c) the possibility that frequency assignments to some space missions could be relocated in bands above 20 GHz;

*resolves*

1. that it is desirable to review the present and planned use of the frequency bands 2 025 - 2 110 MHz and 2 200 - 2 290 MHz, with the intent, when practicable, of assigning frequencies to some space missions in bands above 20 GHz and possibly reducing the allocations to the space services in the 2 GHz band;
  2. that the next competent world administrative radio conference should consider this matter, taking account of the results of the relevant CCIR studies, which may make it possible to revise the Radio Regulations, so that no frequency assignments would be permitted in the bands around 2 GHz after a date in the near future to be determined by that conference for those
- 

space missions whose frequency assignments might be accommodated in the bands above 20 GHz, and so that, if appropriate, the spectrum needs of the mobile and space services might be equitably accommodated in the 2 GHz band;

*invites the CCIR*

1. to carry out the review mentioned in *resolves 1* above;
2. to conduct the necessary studies on the evolution of the space research, space operations, Earth exploration-satellite and mobile services in the bands available to each service around 2 GHz and on the compatibility between these services in the 2 GHz band;
3. to report to the next competent conference the spectrum requirement of each service in the bands mentioned in *invites the CCIR 2* and, where necessary, indicate the criteria for sharing between these services;

*urges administrations*

to participate actively in these studies;

*instructs the Secretary-General*

to bring this Resolution to the attention of the next Administrative Council with a view to including this subject in the agenda of the next competent conference.



UNITED STATES DEPARTMENT OF COMMERCE  
National Telecommunications and  
Information Administration  
Washington, D.C. 20230

September 3, 1985

TA

Mr. Robert O. Aller  
Associate Administrator for  
Space Tracking and Data Systems  
National Aeronautics and Space Administration  
600 Independence Avenue, S.W.  
Washington, D.C. 20546

Dear Mr. Aller:


Members of the NTIA staff met recently with NASA/JSC and JPL spectrum management personnel to discuss spectrum support for the Space Station. I am particularly concerned about the spectrum support for some of the space-to-space links. I understand that NASA is planning to accommodate the space-to-space links for the Space Station multiple-access (MA) system in the 10-18 GHz band due to fiscal constraints. While we certainly understand the fiscal problems associated with developing telecommunications systems above 20 GHz, it must be recognized that implementing long-term, wide-band space-to-space systems below 20 GHz pose significant problems.

The radio communication service performed by the MA system could be accommodated in frequency bands allocated for either space research or inter-satellite. However, there are no inter-satellite bands below 20 GHz and the active space research bands in the 10-18 GHz portion of the spectrum have several disadvantages. They are all secondary, making protection, both nationally and internationally difficult. Some are exclusive Government bands, making it difficult to accommodate commercial activities. Some are shared with important national defense systems making it difficult to protect a secondary system. Also the space research bands were intended for research, not operational links.

The inter-satellite frequency allocation at approximately 23 GHz appears to offer several advantages for the space-to-space links. This band is allocated both nationally and internationally to the inter-satellite service on a primary basis, which allows NASA to obtain protection for these operations. The band is shared between the Government and the non-Government, which would facilitate any related commercialization initiatives. Also the band is presently lightly used. These factors make the 23 GHz inter-satellite band attractive from a regulatory and spectrum management view point for the space station's MA systems.

Though using the higher band may involve some additional expense, I strongly urge NASA to seriously consider this inter-satellite band. The long-term benefits in the areas of protection, congestion and commercialization are so significant that I believe they will dominate the shorter term financial considerations.

Sincerely,

A handwritten signature in dark ink, appearing to read 'W. D. Gamble', with a stylized flourish at the end.

William D. Gamble  
Deputy Associate Administrator  
Office of Spectrum Management



UNITED STATES DEPARTMENT OF COMMERCE  
National Telecommunications and  
Information Administration  
Washington, D.C. 20230  
December 18, 1987

Mr. Robert O. Aller  
Associate Administrator for Space  
Tracking and Data Systems  
National Aeronautics and Space Administration  
600 Independence Avenue, S.W.  
Washington, D.C. 20546

Dear Mr. Aller

I am concerned about NASA's proposal to use the 14.0-14.5 GHz band for various space communications links. NASA has proposed to the Interdepartment Radio Advisory Committee (IRAC) that the National Table of Frequency Allocations be changed to include the space research service on a primary basis. In a separate action, NASA proposed in the system review request submitted to the IRAC's Spectrum Planning Subcommittee (SPS) to use the band 14.0-14.3 GHz for the space station cluster links.

The band 14.0-14.5 GHz is already used extensively nationally and internationally by the fixed-satellite service as an uplink and this use is expected to grow. Within the United States, the only primary allocation in this band is for the non-Government fixed-satellite service uplinks. Thus, these links can be operated without national coordination and without sharing constraints. Changes such as those proposed by NASA that would impose any constraints on existing operations will likely be opposed by the commercial interests.

The process to change the National Table of Frequency Allocations as proposed by NASA is lengthy and the proposed changes will likely meet with considerable opposition from the vested commercial interests. A petition to the Federal Communications Commission (FCC) would be required to initiate a Notice of Proposed Rulemaking by them, steps that could take several years and have a small probability, in my view, of an outcome favorable to NASA. Then service rules to define the sharing arrangements between the existing fixed-satellite service and any other primary service such as space research would be required. This would likely take several more years. Thus, it will take many years before NASA could complete the process to obtain the proposed reallocation in this band and then may find the sharing constraints are unacceptable.

The process to change the International Table of Frequency Allocations is even more lengthy. Modification of the International Telecommunication Union (ITU) Radio Regulations to incorporate the proposed changes would require action by a World Administrative Radio Conference (WARC). Currently there are no WARCS scheduled that are competent to consider such a change and

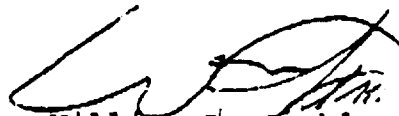
none are foreseen before 1995, well after the space station spectrum related decisions must be made. Also note that under ITU RR2613 non-geostationary space stations shall cease or reduce to a negligible level their emissions whenever there is unacceptable interference to a geostationary-satellite space station in the fixed-satellite service. Thus, even if the allocation tables are changed to primary and sharing arrangements are defined, the cluster links in this band are on a non-interference basis to the geostationary-satellite space systems in the fixed-satellite service.

Considering the uncertainty and the time delays required to resolve NASA's proposals, NTIA will not certify spectrum support for space systems in the band at this time. Accordingly, the request for spectrum support for the space station cluster links in the 14.0-14.3 GHz band is denied until the national allocation issue is resolved, which will probably be at least five years. Spectrum support for any satellites which require allocation in this band will be withheld until the applicable changes are made and required sharing criteria established.

I continue to urge NASA to consider bands above 20 GHz for space station cluster links. In particular, the bands 22.55-23.5 GHz and 25.25-27.0 GHz should be considered. Also the SPS is currently considering 21.4-22.0 GHz as a candidate band. While I recognize that the current regulatory provisions in the bands do not meet NASA's full requirements, the NTIA and the FCC will provide considerably more flexibility in these bands since there are very few operations in them.

NTIA will continue to work with NASA to find a compromise solution to meet the space station spectrum requirements within the various economic, technical, operational, and regulatory constraints.

Sincerely,



William D. Gamble  
Deputy Associate Administrator  
Office of Spectrum Management



**ESA / NASA / NASDA**

**Space Networks Interoperability Panel**

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**RECOMMENDATIONS**

**for**

**International Space Network**

**Ka-Band Interoperability**

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**Revision 1 : June 1995**

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**RECOMMENDATIONS**  
**for**  
**International Space Network**  
**Ka-Band Interoperability**

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**Revision 1 : June 1995**

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Approved : Klaus Lenhart  
Klaus Lenhart, ESA Co-Chairman

Approved : Thomas E Ryan  
Thomas Ryan, NASA Co-Chairman

Approved : Katsuyoshi Arai  
Katsuyoshi Arai, NASDA Co-Chairman

## Preface

The current plans of ESA, NASA and NASDA foresee operational data relay satellite systems in operation around the end of the 1990's, all using the same Ka-band IOL frequency bands :

23.12 - 23.55 GHz forward and  
25.25 - 27.50 GHz return

These recommendations, first signed on behalf of NASA, ESA and NASDA in Tokyo on 2 May 1991, are the result of the SNIP Ka-Band study activity and are hereby approved SNIP technical recommendations for the data relay satellite systems of the three Agencies.

This Revised Recommendation reflects changes since May 1991.

Note "Notes" following each Recommendation are added to indicate where non-compliance is currently foreseen.

### 1. Link Budgets

SNIP has studied the link budgets for interoperability between the three systems, based on their declared characteristics, principally :

|                 | EIRP towards<br>User S/C | G/T towards<br>User S/C |                                  |
|-----------------|--------------------------|-------------------------|----------------------------------|
| ESA DRS         | 61.3 dBW<br>57.3 dBW     | 22.3 dB/K<br>19.3 dB/K  | auto-track<br>open-loop pointing |
| NASDA DRTSS     | 61.5 dBW<br>59.0 dBW     | 26.5 dB/K<br>24.0 dB/K  | auto-track<br>open-loop pointing |
| NASA TDRS/H,I,J | 63.0 dBW<br>59.5 dBW     | 26.5 dB/K<br>23.0 dB/K  | auto-track<br>open-loop pointing |

and has concluded that all combinations of user spacecraft and host relay satellite are capable of supporting a useful forward and return interoperability service.

2. Field of View

SNIP recommends that data relay satellites be able to transmit and receive IOL signals with a minimum conical field of view of  $\pm 10^\circ$  about the satellite-to-Earth centre axis.

3. Forward Link Frequency Framework

SNIP recommends that data relay IOL forward channel centre frequencies be selected from the following :

23.205 GHz  
23.265 GHz  
23.325 GHz  
23.385 GHz  
23.445 GHz  
23.505 GHz

SNIP recommends that each data relay satellite shall be able to transmit forward IOL signals on any of the above frequencies, with a minimum bandwidth of 50 MHz.

**Note** ESA DRS Satellites are not currently specified to provide the forward IOL frequency at 23.505 GHz, as analyses show that excessive interference may be generated by transmissions in this channel at the beacon frequencies, 23.540 GHz and 23.545 GHz.

4. Return Link Frequency Framework

SNIP recommends that data relay IOL return link channel centre frequencies be selected from the following :

25.600 GHz  
25.850 GHz  
26.100 GHz  
26.350 GHz  
26.600 GHz  
26.850 GHz  
27.100 GHz  
27.350 GHz

SNIP recommends that each data relay satellite shall be able to receive return IOL signals on any of the above frequencies, with a minimum bandwidth of 225 MHz on all frequencies.

5. Polarisation

SNIP recommends that data relay satellites and user spacecraft be able to operate either on LHCP or RHCP, with the same polarisation for the selected forward and return IOL frequencies.

**Note** The ESA ARTEMIS Satellite will use opposite polarisations for forward and return Ka-band IOLs. However, the ESA DRS Satellites will conform to the above Recommendation.

6. Polarisation Purity

SNIP recommends that the IOL antenna axial ratio of data relay satellites be not greater than 1.5 dB over the 3 dB beamwidth.

7. Forward Beacon

SNIP recommends that each relay satellite be able to generate, in the direction of any interoperable-user spacecraft, a reference signal to allow user spacecraft antenna acquisition.

This reference signal may be either an unmodulated carrier, transmitted with the same frequency and polarisation as the user forward IOL signal, or a wide-beam beacon, transmitted on LHCP at one of the following frequencies, selected in coordination with the other SNIP participating Agencies :

23.530 GHz  
23.535 GHz  
23.540 GHz  
23.545 GHz

The reference signal EIRP towards the User Spacecraft should be +24 dBW minimum.

**Note** The NASA TDRS H, I, J satellites will not provide a wide-beam beacon but will be able to provide for an unmodulated forward signal to be transmitted at the same frequency and polarisation as the user forward IOL signal to allow for user spacecraft antenna acquisition.

8. Return Signal Tracking

SNIP recommends that relay satellite return-link tracking, if required, should operate on the modulated signal, at the return frequency selected by the user.

9. Dual-Band IOL Operation

SNIP recommends that all relay satellites be able to provide two-way (forward and return) interoperable IOL service to user spacecraft in both S-band and Ka-band simultaneously.

Note The ESA ARTEMIS Satellite is able to provide simultaneous S-band and Ka-band return IOL service together with forward service in one band only.

10. User Spacecraft Tracking

SNIP makes no recommendations for user spacecraft tracking services via interoperable data relay satellites using Ka-band IOLs.

11. Modulation Scheme

SNIP recommends the use of any of the following modulation schemes for IOL services :

For forward links :

BPSK, QPSK, UQPSK, with no forward error-correction coding;

For return links :

BPSK, QPSK, UQPSK, either [with forward error-correction coding ( $R=1/2$ ,  $k=7$ )] or with no coding.

Note ESA support of SNIP modulation recommendations is dependent on the availability of suitable ground terminals.